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OPHTHALMOMETRY WITH THE OPHTHALMOMETER OF JAVAL AND SCHIÖTZ, WITH AN ACCOUNT OF A CASE OF KERATOCONUS

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OPHTHALMOMETRY WITH THE OPHTHALMOMETER OF JAVAL AND SCHIÖTZ, WITH AN ACCOUNT OF A CASE OF KERATO-CONUS.

By SWAN M. BURNETT, Washington.

(*With three wood-cuts.*)

JAVAL and Schiötz exhibited their perfected ophthalmometer at the meeting of the International Medical Congress held in London in 1881. I have not been able to find, however, any published papers, embodying results of experimentation with the instrument by others, outside of two or three on the continent.[1]

In England and America, so far as my knowledge of their ophthalmic literature extends, no publication has been made.[2]

Having used one of these instruments in my daily practice for some months, I feel it but due to the ingenious inventors, and hope it may be not without interest to the practical ophthalmologist, to place the results of my observations on record.

Any description of the instrument itself is not necessary here, since this is accessible in the papers published by the inventors in the *Annales d'oculistique* for Juil.–Août, 1881; Mai–Juin, 1882; Juil.–Août, 1882; and Jan.–Fév., 1883. These articles contain all that is necessary for a thorough understanding of the principles on which the instrument is built, the method of its construction, and the manner of

[1] Laqueur, *Gräfe's Archiv*, xxx., 1, p. 99; Angelucci, *Ann. di Ott.*, xiii., fas. i., p, 35.

[2] Juler (*Brit. M. J.*, 1884, ii., p. 1274) speaks disparagingly of the instrument.

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using it. From a careful reading of them, no practitioner with a knowledge of the fundamental principles of optics can have any difficulty in taking the instrument from its packing-case, setting it up, and manipulating it with satisfaction.

Its prime, and indeed only, function is the determination of the character of the corneal curvature.[1] That is its limitation; but when we consider that astigmatism is almost wholly corneal, and that it forms more than one half of the cases of refractive anomalies presenting for treatment, the importance of knowing the exact curvature of the cornea in all its meridians becomes apparent.

The ophthalmometer does not give us the refractive condition of the eye as a whole, and furnishes no positive indication as to the existence of myopia or hypermetropia,[2] but it gives with exactness the radius of curvature of the cornea in all its meridians; and, where there is a difference, it shows the direction of the principal meridians, and we can read on the instrument the amount of the difference in dioptries and fractions. The inventors claim that a difference of 0.25 D can be readily detected, and my own experience would substantiate this statement.

The main question is: Is it practical? I most unhesitatingly answer: Yes. Taking all things into consideration, it seems to me the most practical of all the instruments of precision we use in the diagnosis of astigmatism. I have found many ophthalmologists who have confessed that they did not rely on the ophthalmoscope in the diagnosis of refractive anomalies. That seems to be an art which all cannot learn; but I can hardly imagine a practising oculist

[1] For which reason I think the term *keratometer* much more accurately descriptive than ophthalmometer. The term *keratoscopie* should be reserved for a simple inspection of the corneal surface without any measurements, as with Placido's circles or Wecker's square.

[2] Since writing the above, I have examined a case which demonstrates this very perfectly. In the left eye 110° had $r = 7.8$ *mm.*; 10°, $r = 8.4$ *mm.*; in the right eye 80° had $r = 7.8$ *mm.*; 170°, $r = 8.4$ *mm.* In both the bands crossed 1¼ steps. When it came to correction, however, it was found that L required +1.25 (110°), while R required −1.25 (80°). As the person was over sixty years of age, we could hardly suppose the existence of spasm of A in R. The M must therefore have been due to an elongation of the antero-posterior axis of the globe, of which fact, of course, the ophthalmometric measurements gave us no hint. I have also examined two cases in which M = 10 D existed in one eye, and E in the other; but both corneæ had the same radius of curvature.

that could not manipulate the ophthalmometer with success —certainly to the extent of detecting an astigmatism of 0.5 D.

Another advantage is the rapidity with which examination can be made. When the instrument is in position, it consumes even less time than an expert would take in making the same determination with the ophthalmoscope—that is, less than two minutes, including the reading and recording of the measurements.

No other form of keratoscopy can compare with it for precision and accuracy. I have used Placido's disc and Wecker's square, but must confess that in regular astigmatism I have found them worthless. They sometimes, in astigmatism of high degree, give indications as to the direction of the principal meridians, but I have never been able to estimate within two or three dioptries of the degree.

It is in cases of astigmatism of high degree, and particularly in mixed astigmatism, where the instrument of Javal is of most essential value, for it is precisely in such cases that the subjective methods of examination are so tedious. With the ophthalmometer you obtain at a glance the data required for a speedy solution of the difficulty.

I will not lengthen this paper by giving any tabular statistics, suffice it is to say that in about 100 astigmatic eyes I have not found a difference of more than 1 D between corneal and total astigmatisms, and that only in a single case. I will relate one case of kerato-conus in full, which not only shows the value of the instrument, but has also, I think, an interest and importance of its own.

Mrs. R., twenty-seven years of age, says she saw well up to her sixteenth year. At that time her vision began to fail, and gradually got worse until her nineteenth year, since which time it has remained about as it is now. On October 6, 1884, the time of the first examination, $V = \frac{2}{60}$. With -6^s she saw with either eye No. 60 at 4 metres, and no other spherical lenses gave further improvement. As is my habit, I then made an ophthalmoscopical examination before trying cylinders, since I thereby obtain at least some indications of the nature of the trouble, particularly if there is a high degree of astigmatism. On making this examination I at once found that I had to deal with a case of kerato-conus.

Even in the inverted image it was not possible to see all parts of the disc clearly, and there was that excessive parallactic movement of the vessels which is so characteristic of kerato-conus when this method of examination is used. When the light from a plain mirror was thrown into the pupil from a distance, as in the shadow test,[1] the peculiar unstable shadow crescent of conical cornea was beautifully shown. Examination by the direct method was in the highest degree unsatisfactory. At no time, and with no lens, could I get more than a part of two or three vessels in focus at once, and the least movement of the eye would throw those out of view and bring others forward. Some idea of the peculiar distortion of the vessels may be obtained from the accompanying diagram (fig. 1), which represents the disc as seen in the R eye, with

FIG. 1.

+ 4 behind the ophthalmoscope. The black lines represent the parts of the vessels which were seen distinctly; the shaded portion, the parts that were out of focus.

The ophthalmoscope, therefore, which in cases of regular astigmatism of high degree is invaluable in giving us a clue to the character of the anomaly, was here of no avail.

The average radius of curvature of the normal cornea is somewhat less than 8 *mm.* In Mrs. R. the radius of curvature of the cornea was shortened in all the meridians, and in different parts of the same meridian, and a wide departure from the normal was found. The most nearly regular part was found, not directly in the line of vision, but about five degrees outwards in each eye. When in this position, the meridian in the R at 10° had a radius of curvature of only 5.4 *mm.*, and at 110° a radius of 6.8. The

[1] I think this name is preferable to keratoscopy, retinoscopy, pupilloscopy, phantoscopy, or any of the others that have been applied to this method of examination. Perhaps, for scientific nomenclature, we had better adopt the word *skiascopy*, as suggested by the French Hellenist, M. Egger.

left cornea had a radius in about the same locality of 5 *mm.* in the meridian at 180°, and of 6 *mm.* in the meridian at 90°. Even in these meridians there was a rapid change in these figures as soon as the point of measurement was removed a few degrees from the place indicated. The shape of the bands became very much distorted, and it was impossible to take accurate measurements. It was very evident, however, that the corneal surface became flatter as it approached the periphery. The distortion began much sooner on the outer side of the point indicated in both eyes. In R I measured the radius in 180° at some 20 degrees out and in from the apex, and found it inwards 7.5 *mm.*, and outwards 8 *mm.*, approximatively. The distortion was also greater in the upper than in the lower portion of the cornea.

These measurements, while showing a very great irregularity in the corneal curvature, gave me an idea of the direction of the meridians of greatest and least refraction near the visual axis, which was of great value in my further unravelling of the tangled threads of evidence. I read off on the arc of the instrument that in L, 180° had about 38 D, and 90° had 34 D—the difference being 4 D; and when the bands were in contact at 90°, they crossed 3½ steps of the graded arc at 180°. In R, 10° had 36 D (the normal being near 20), and 110° had 30 D, and the bands were superposed 6 steps at 10°, when they were in contact at 100.°

These data gave me no hint of the *character* of the regular astigmatism, but I now knew the *amount*, and approximately the direction of the principal meridians.

From the very short radius of curvature in all meridians, we naturally expected to find a high degree of myopia, but on testing with glasses it was found that while in L, with $-9-4^{cy}$ 180°, some letters of No. 12 were made out, in R some of No. 9 were seen, with $+4^{cy}$ 180° -2.5^{cy} 90°. No. 1, of Wecker was read by both at 8 inches. It should be stated that the examinations with glasses were repeated many times, and under the full effect of atropine; and the result as regards vision was the same with the same glasses, with and without the mydriatic.

Javal has added a Placido's disc to his instrument since 1881, and it has increased its value very much for the determination of *irregular* astigmatism. I had found the disc of Placido very useful for this purpose, and by it have discovered varying degrees of irregular astigmatism in many cases where V could not be

brought up to $\frac{20}{20}$ by any optical means. As we always have a certain and usually a very large amount of irregular astigmatism[1] in kerato-conus, I made careful examinations of both eyes of Mrs. R with the disc.

In fig. 2 is found the form of the disc at the corneal apex, 15° upward and downward, and 20° on either side in the left eye.

It will be observed in these figures that even at the apex there is quite a distortion below and to the outer side, while in all directions towards the base of the cornea the peripheral portions of the rings are drawn out and flattened, indicating a great reduction of its curvature at this portion of its surface. The striking feature about these figures, however, is their close approach to uniformity and similarity in form, indicating a much greater regularity of curvature than is

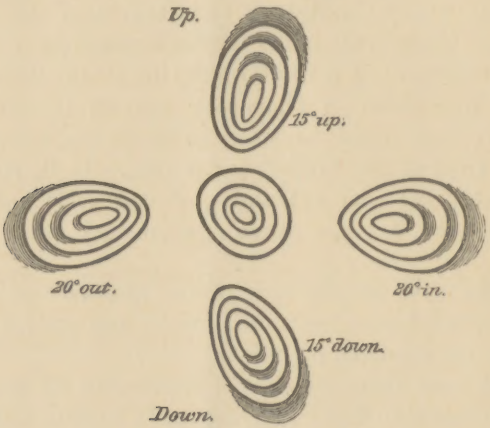

FIG. 2.

usually found in conical cornea, and much more regularity at apex than the cornea of the case of recent extraction of the cataract shown in fig. 3. In fact, if we are to judge from these figures, the cornea approaches in form in this instance to an ellipsoid of revolution, though of course we know by ophthalmometer measurements that there is a compression laterally, as shown by the existence of so large an amount of regular astigmatism. Such a case would seem, theoretically, to be well adapted to the use of hyperbolic lenses,

[1] See a paper by Angelucci in *Ann. di Ottal.*, xiii., 84, fas. 1.

and I much regret that I did not have an opportunity of trying them.

But the results obtained by cylindrical lenses are very gratifying, and encourage us to hope that with the aid of the ophthalmometer, many cases of kerato-conus, which have heretofore been deemed fit only for operation, will find a remedy in optical appliances.[1]

In the R eye the images of the circles were even more regular in form than in the L, and there was much less distortion at the apex of the cornea, and this is the eye which received the greatest benefits from the cylindrical lenses, vision being brought up to nearly $\frac{4}{9}$.

I have made ophthalmometric measurements of three eyes on which I had operated for cataract by extraction. Unfortunately none of these eyes were so examined before the operation, but it is a fair assumption that both eyes were nearly alike when the patients so state. In one there was that rather rare accident of a reopening of the wound nine days after the operation, and the examination was made only four days after it had again closed. At that time there was an astigmatism of 5.5 D in the meridian at 45°, corresponding pretty well with the place where the wound had given way, and the radius of curvature in that meridian was more than one millimetre longer than in the meridian at 135°. Examined fourteen days later, a marked change was found. 45° had now only 8.1 *mm*, while 135° had 8.4 *mm* radius, the difference amounting to 1.25 D, the *shorter* radius being now at 45°. When a + 1^{cy} with the axis at 45° was added to his cataract glass vision was much improved. In the second case the operation was a typical one, with Wecker's incision wholly in the cornea. There was no reaction until the ninth day, when an iritis set in. The wound had closed perfectly, but cicatrization was not complete on the eleventh day, when I made opthalmometric measurements. The extraordinary degree of irregular astigmatism is shown by the distortion of Placido's disc in fig.

[1] It now becomes a possibility that the hyperbolic lenses of Raehlmann, which have afforded decided advantage in cases of kerato-conus over cylinders, can be manufactured to order to suit each particular case from data furnished by the keratometric measurements.

3. Combined with this there was also a very large amount of regular astigmatism, as indicated by the elongated form of the disc.

On measuring the corneal curvature I found that 90° had $r = 9.9$ *mm* (11 D); 180°, $r = 8.$ (21 D); making a difference of 10 D. The cornea of the other eye (which was also cataractous) was free from astigmatism of any kind. It is interesting to note that the other eye, operated on since the above was written, followed the same course, the iritis lasting six weeks. It was accompanied by analogous changes in the corneal curvature. Both corneæ became subsequently almost normal in curvature.

In another case, four weeks after extraction, in which there were no complications, either during or subsequent to

FIG. 3.

the operation, there was a corneal astigmatism of 2.25 D, the more strongly curved meridian being at 100°; and vision was much improved by the addition of this cyl. to this spherical. The fellow-eye showed no abnormality in its corneal curvature. Measurements ten days subsequently showed a decrease of the astigmatism to 1.5 D.[1]

A number of accurate ophthalmometric measurements of eyes operated on for cataract by extraction, would give us valuable indications as to the kind of section which would be likely to give us a minimum of deformity in the corneal curvature.

Another field for usefulness of the ophthalmometer will be in the selection of a place for making an iridectomy in cases of leucoma of the cornea etc., where there is left any choice of clear cornea. The instrument will show us at once which portion of the corneal surface is most nearly regular, and under that we can make the artificial pupil.

[1] See papers on this subject by L. Weiss, These ARCHIVES, vi., p. 432; and Laqueur's paper, *l. c.*

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